FORM PTO-1390 (REV. 5-93)	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER **11839/12**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/979568

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATES CLAIMED
PCT/EP00/04072	**(06.05.00) 06 May 2000**	**(11.05.99) 11 May 1999**

TITLE OF INVENTION

ROTARY SLIDE VALVE FOR POWER-ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES

APPLICANT(S) FOR DO/EO/US

BREITWEG, Werner and SCHÄNZEL, Rainer

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unexecuted)
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☒ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report with an English translation thereof; English translation of the International Preliminary Examination Report, two (2) sheets of drawings; Marked-up version of the substitute specification and the first page of the published International Application WO 00/68061.

EXPRESS MAIL NO. : EL327552601US

U.S. APPLICATION NO. (If known, see 37 C.F.R.1.5) 09/979568	INTERNATIONAL APPLICATION NO. PCT/EP00/04072	JC10 Rec'd PCT/PTO 05 NOV 2001 ATTORNEY'S DOCKET NUMBER 11839/12

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO $890.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $710.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	12 - 20 =	0	X $18.00		
Independent Claims	1 - 3 =	0	X $84.00		
Multiple dependent claim(s) (if applicable)			+ $280.00		
TOTAL OF ABOVE CALCULATIONS =				$ 890.00	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 890.00	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$ 890.00	
				Amount to be: refunded	$
				charged	$ **890.00**

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. **11-0600** in the amount of **$890.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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26646
PATENT TRADEMARK OFFICE

SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

11/5/01
DATE

[11839/12]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)	:	Werner BREITWEG et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	ROTARY SLIDE VALVE FOR POWER-ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES
Examiner	:	To Be Assigned
Art Unit	:	To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

S I R:

Kindly amend the above-captioned application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

On the first page of the claims, first line, change "Patent Claims" to --WHAT IS CLAIMED IS:--.

Please cancel, without prejudice, claims 1 to 10 in the underlying PCT application.

Please add the following new claims:

--11. (New) A rotary slide valve for a power-assisted steering system of a motor vehicle, comprising:

a torsion-bar spring;

a backlash coupling;

a connecting element;

a valve input member;

a valve output member;

a valve housing;

a first valve element rotationally fixedly connected to the valve input member and connected to the valve output member via the torsion-bar spring, the backlash coupling and the connecting element, the connecting element including at least one cut disposed in a first region between a connection region and a control region; and

a second valve element rotationally fixedly connected to the valve output member;

wherein the first valve element and the second valve element are arranged coaxially movable one in the other in the valve housing and are rotatable relative to one another at most by an amount of rotary travel of the backlash coupling, a radially outer one of the first valve element and the second valve element having inner longitudinal control grooves, a radially inner one of the first valve element and the second valve element having outer longitudinal control grooves, an axial length of the control grooves being at least partially limited, the control grooves being configured to cooperate with one another to control a pressure medium to and from two working spaces of a servomotor.

12. (New) The rotary slide valve according to claim 11, wherein the control grooves are configured conically to adjust a characteristic curve.

13. (New) The rotary slide valve according to claim 11, wherein the first valve element and the valve output member are connected one of positively and nonpositively.

14. (New) The rotary slide valve according to claim 13, wherein one of the connecting element and the valve output member includes a boss contour.

15. (New) The rotary slide valve according to claim 11, wherein the first region is torsionally rigid and flexible.

16. (New) The rotary slide valve according to claim 11, wherein the cut is continuous.

17. (New) The rotary slide valve according to claim 11, wherein the cut includes a groove.

18. (New) The rotary slide valve according to claim 11, wherein the first region includes a hollow shaft.

19. (New) The rotary slide valve according to claim 11, wherein the first region includes a solid shaft.

20. (New) The rotary slide valve according to claim 11, wherein the first region includes a polygonal profile.

21. (New) The rotary slide valve according to claim 11, wherein the cuts are formed by one of high-energy beam cutting, plasma cutting, erosion cutting, punching, grinding and milling.

22. (New) The rotary slide valve according to claim 11, wherein the connecting element includes a control bush, the connecting element being formed at least in one piece with the control bush.--.

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 10 in the underlying PCT Application No. PCT/EP00/04072 and adds new claims 11 to 22. The new claims, inter alia, conform the claims to U.S. Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to

conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(iii) and 1.125(b)(2), a Marked Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/EP00/04072 includes an International Search Report, dated September 19, 2000, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

The underlying PCT Application No. PCT/EP00/04072 also includes an International Preliminary Examination Report, dated February 19, 2001. An English translation of the International Preliminary Examination Report is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

KENYON & KENYON

Dated: 11/5/01

By: [signature]

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[11839/12]

ROTARY SLIDE VALVE FOR POWER-ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES

FIELD OF THE INVENTION

The present invention relates to a rotary slide valve for power-assisted steering systems of motor vehicles.

BACKGROUND INFORMATION

Rotary slide valves for power-assisted steering systems normally contain two valve elements which are arranged so as to be movable coaxially one in the other and are arranged so as to be rotatable relative to one another to a limited extent in order to achieve a control travel. In this case, the first valve element, which is connected to a valve input member, is designed as a radially outer rotary slide. A second valve element is connected fixedly in terms of rotation to a valve output member designed as a driving pinion and is designed as a radially inner control bush. The rotary slide is additionally connected to the driving pinion via a backlash coupling limiting a control travel. Both valve elements have longitudinal control grooves which are limited at least partially in their axial extent and serve for controlling a pressure medium from or to working spaces of a servomotor.

A torsion-bar spring serves for resetting the two valve elements from a deflected position into their neutral position.

In conventional rotary slide valves, the control bush is suspended in a suspension pin pressed into the driving pinion. For this assembly step, it is necessary to have play in the suspension connection between the suspension pin and the

control bush. However, because of the play which is present, a relative movement may occur between the rotary slide and the control bush, without a steering torque having been introduced by a steering handwheel. This results in undesirable oil streams to the working spaces of the servomotor. These undesirable oil streams are manifested, in addition, by steering torque jumps on the steering handwheel, which result in selfsteering effects and may therefore lead to the driver having a feeling of uncertainty.

In the rotary slide valves described above, the rotary slide is connected fixedly to the valve input member and the control bush to the valve output member. There are, however, also conventional rotary slide valves which operate with valve elements assigned in reverse. The invention present may be used, along with the same benefits, for these rotary slide valves.

The valve output member may be designed as a driving pinion or as a ball screw, depending on use in rack-and-pinion or ball-and-nut power-assisted steering systems.

Such a rotary slide valve is described in German Published Patent Application No. 41 08 597.

The rotary slide valve is designed so that the engagement dimensions of the take-up connection are sufficiently large to ensure a firm fit, without this resulting in a large-size valve assembly. The take-up pin, which projects at right angles from an outer circumference of the pinion shaft, is inserted into a pin hole which extends in the radial direction of the valve bush. The pinion shaft is thereby operatively connected to the valve bush. The mid-axis of the inside

diameter of the valve bush intersects the mid-axis of the pin hole and is displaced from the mid-axis of the valve assembly in the direction of that side of the valve assembly which is located opposite the pinhole.

It is an object of the present invention to provide a rotary slide valve, in which the play between the valve input member and the valve output member is eliminated and angular and longitudinal movability is maintained between a valve element configured as a control bush and a valve output member configured as a driving pinion, in order to allow the compensation of lateral error.

SUMMARY

The foregoing object of the present invention is achieved by providing a rotary slide valve as described herein.

The connection of the control bush to the driving pinion is made by a tolerance-insensitive and play-free press connection in the form of a connecting element. The connecting element may be connected in one piece to the control bush or may be coupled to the control bush by forming or joining.

The control bush or the connecting element may be configured in the connection region as a solid shaft, a hollow shaft or a polygon.

The connecting element may have a profile, for example, in the form of a boss located on the circumference, which profile may be applied both to the control bush and in the driving pinion. It is necessary merely to ensure a tolerance-insensitive, centric and play-free connection of the two parts.

By virtue of a flexible configuration of a region between a connection region of the control bush and the driving pinion and a control region of the control bush, transverse forces acting from outside may be distributed uniformly and the two parts may therefore be fixed, free of play, relative to one another. Lateral and angular errors which are present may thereby be compensated so that there are no distortions within the rotary slide valve.

The flexibility of the region between a connection region of the control bush and the driving pinion and a control region of the control bush is obtained by the introduction of at least one cut and is influenced by the width, depth and length of the latter and by the arrangement and density of the cuts.

The cuts are introduced by high-energy beam cutting, plasma cutting, erosion cutting, punching, grinding or milling.

Forces acting from outside, such as distortions in the steering column, elastic influences or different thermal expansions of the individual components in relation to one another, which adversely influence the functioning of previous rotary slide valves, are avoided. Production tolerances may also be compensated in terms of their influences on the functioning of the rotary slide valves.

Assembly is performed merely by joining together axially. This arrangement provides advantages with regard to the outlay in terms of production and assembly.

Assembly may also be performed fully automatically with the aid of force/path monitoring, thus leading to a higher reproducibility of quality and functioning.

An example embodiment of the present invention is described below with reference to the several Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a longitudinal cross-sectional view through a rotary slide valve according to the present invention by the example of a rack-and-pinion power-assisted steering system of a motor vehicle.

Figure 2 is an enlarged view of a rotary slide valve according to the present invention.

Figure 3 is a cross-sectional view taken along the line III-III of the rotary slide valve illustrated in Figure 2.

DETAILED DESCRIPTION

The present invention is described with reference to the example of a rotary slide valve for a rack-and-pinion power-assisted steering systems. The invention may, however, also be applied, to the same effect, to other power-assisted steering systems, for example ball-and-nut power-assisted steering systems.

A rotary slide valve 1 according to the present invention includes a first valve element in the form of a rotary slide 2 and a second valve element which is configured as a control bush 3.

The rotary slide 2 is connected fixedly in terms of rotation to a valve input member 4 which may be configured as a steering spindle connection. The steering spindle connection is connected, for example, to a steering spindle which carries a steering handwheel, via a cardan joint. Moreover, the

rotary slide 2 is connected to a valve output member 5 via a backlash coupling.

The valve output member 5 may be configured as a driving pinion or as a ball screw, depending on use in rack-and-pinion or ball-and-nut power-assisted steering systems.

Arranged on the outer cylindrical surface of the rotary slide 2 are longitudinal control grooves 6 which cooperate with longitudinal control grooves 7 of the control bush 3.

Depending on the direction of rotation, the rotary slide valve 1 makes a pressure-medium connection with a servomotor via the longitudinal control grooves 6 and 7 and via annular grooves 8 in the control bush 3.

Furthermore, the valve input member 4 is connected to the valve output member 5 via a torsion-bar spring 9. The valve output member 5, in turn, is connected fixedly in terms of rotation to the control bush 3 via a connecting element 10. These various connections with one another make it possible to have a limited relative rotation of the rotary slide 2 in relation to the control bush 3. As a result of this relative rotation of the valve elements in relation to one another, the pressure medium conveyed by a power-steering pump is conducted, via a pressure-medium reservoir, from the relieved working space of the servomotor into the loaded working space of the latter.

The coupling of the valve output member 5 and the control bush 3 is achieved by a connecting element 10 which is connected in one piece to the control bush 3 here. The connecting element 10 is pressed into the valve output member 5 and is secured

against rotation by a boss contour 11. This arrangement allows a play-free take-up. The connecting element 10 is connected to the valve output member 5 in a connection region 12. The connection region 12 is spatially separated from a control region 13 of the control bush 3 by a region 14. In this region 14, at least one cut 15 is made, which ensures torsional rigidity and flexibility of this region 14.

ABSTRACT

A rotary slide valve for power-assisted steering systems of motor vehicles includes a rotary slide which is connected fixedly in terms of rotation to a valve input member. The control bush is connected fixedly in terms of rotation to a valve output member. The two valve elements are arranged so as to be movable coaxially one in the other and are rotatable relative to one another at most by the amount of the rotary travel of a backlash coupling. The rotary slide has outer and the control bush inner longitudinal control grooves which cooperate with one another in order to control a pressure medium to and from two working spaces of a servomotor. The rotary slide is connected to the valve output member via a torsion-bar spring. Production-related tolerances which may lead to undesirable effects in driving behavior are compensated by a connecting element.

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(81) Bestimmungsstaaten: AU, BR, CN, JP, US, europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

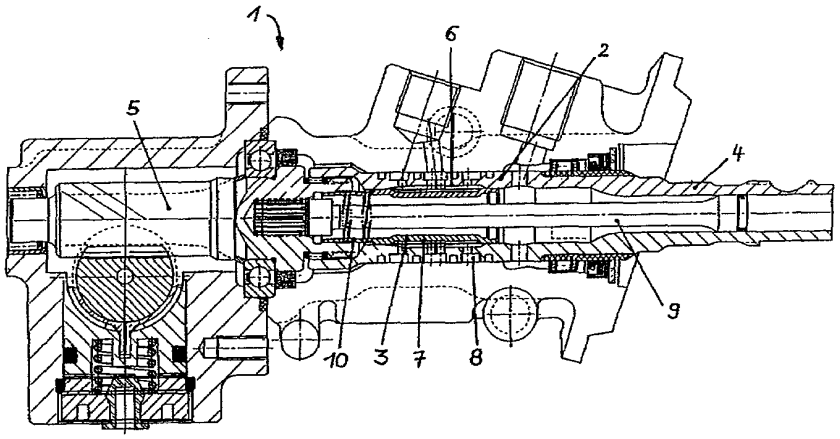
Veröffentlicht
Mit internationalem Recherchenbericht.
Vor Ablauf der für Änderungen der Ansprüche zugelassenen Frist; Veröffentlichung wird wiederholt falls Änderungen eintreffen.

(54) Title: ROTARY SHIFT VALVE FOR SERVO–ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES

(54) Bezeichnung: DREHSCHIEBERVENTIL FÜR HILFSKRAFTLENKUNGEN VON KRAFTFAHRZEUGEN

(57) Abstract

The invention relates to a rotary shift valve (1) for servo–assisted steering systems of motor vehicles. Said valve (1) comprises a rotary disc (2) which is connected to a valve input member (4) in a rotationally–fixed manner. The control bush (3) is connected to the valve output member (5) in a rotationally–fixed manner. The two valve elements are arranged coaxially such that they can move within one another and can be rotated in relation to one another about the rotational travel of a backlash coupling. The rotary disc (2) is provided with external longitudinal control grooves (6, 7) and the control bush (3) is provided with internal longitudinal control grooves (6, 7). Said grooves engage with each other for controlling a hydraulic fluid towards and away from two working chambers of a servomotor. The rotary disc (2) is connected to the valve output member via a torsion–bar spring (9). Manufacturing–related tolerances which can create undesired effects of the performance are compensated by a connection element (10).



[11839/12]

ROTARY SLIDE VALVE FOR POWER-ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES

The invention relates to a rotary slide valve for power-assisted steering systems of motor vehicles of the type defined in more detail in the preamble of claim 1.

Rotary slide valves for power-assisted steering systems normally contain two valve elements which are arranged so as to be movable coaxially one in the other and are arranged so as to be rotatable relative to one another to a limited extent in order to achieve a control travel. In this case, the first valve element, which is connected to a valve input member, is designed as a radially outer rotary slide. A second valve element is connected fixedly in terms of rotation to a valve output member designed as a driving pinion and is designed as a radially inner control bush. The rotary slide is additionally connected to the driving pinion via a backlash coupling limiting a control travel. Both valve elements have longitudinal control grooves which are limited at least partially in their axial extent and serve for controlling a pressure medium from or to working spaces of a servomotor.

A torsion-bar spring serves for resetting the two valve elements from a deflected position into their neutral position.

In the known rotary slide valves, the control bush is suspended in a suspension pin pressed into the driving pinion. For this assembly step, it is necessary to have play in the suspension connection between the suspension pin and the control bush. However, because of the play which is present,

a relative movement may occur between the rotary slide and the control bush, without a steering torque having been introduced by a steering handwheel. This results in undesirable oil streams to the working spaces of the servomotor. These undesirable oil streams are manifested, in addition, by steering torque jumps on the steering handwheel, which result in selfsteering effects and may therefore lead to the driver having a feeling of uncertainty.

In the exemplary embodiments described hitherto, the rotary slide is connected fixedly to the valve input member and the control bush to the valve output member. There are, however, also rotary slide valves which operate with valve elements assigned in reverse. The invention may likewise be used, along with the same benefits, for these rotary slide valves.

The valve output member may be designed as a driving pinion or as a ball screw, depending on use in rack-and-pinion or ball-and-nut power-assisted steering systems.

Such a rotary slide valve is described in DE 41 08 597 A1.

The rotary slide valve is designed in such a way that the engagement dimensions of the take-up connection are sufficiently large to ensure a firm fit, without this resulting in a large-size valve assembly. The take-up pin, which projects at right angles from an outer circumference of the pinion shaft, is inserted into a pin hole which extends in the radial direction of the valve bush. The pinion shaft is thereby operatively connected to the valve bush. The mid-axis of the inside diameter of the valve bush intersects the mid-axis of the pin hole and is displaced from the mid-axis of the

valve assembly in the direction of that side of the valve assembly which is located opposite the pinhole.

The object on which the present invention is based is to present a rotary slide valve, in which the play between the valve input member and the valve output member is eliminated and angular and longitudinal movability is nevertheless maintained between a valve element designed as a control bush and a valve output member designed as a driving pinion, in order to allow the compensation of lateral error.

The object on which the invention is based is achieved by means of a generic rotary slide valve also having the defining features of the main claim.

The connection of the control bush to the driving pinion is made by means of a tolerance-insensitive and play-free press connection in the form of a connecting element. The connecting element may be connected in one piece to the control bush or else be coupled to the control bush by forming or joining.

The control bush or the connecting element may be designed in the connection region as a solid shaft, a hollow shaft or a polygon.

The connecting element may have a profile, for example in the form of a boss located on the circumference, which profile may be applied both to the control bush and in the driving pinion. It is necessary merely to ensure a tolerance-insensitive, centric and play-free connection of the two parts.

By virtue of a flexible configuration of a region between a connection region of the control bush and the driving pinion and a control region of the control bush, transverse forces acting from outside can be distributed uniformly and the two parts can therefore be fixed, free of play, relative to one another. Lateral and angular errors which are present can thereby be compensated in such a way that there are no distortions within the rotary slide valve.

The flexibility of the region between a connection region of the control bush and the driving pinion and a control region of the control bush is obtained by the introduction of at least one cut and is influenced by the width, depth and length of the latter and by the arrangement and density of the cuts.

The cuts are introduced by high-energy beam cutting, plasma cutting, erosion cutting, punching, grinding or milling.

Forces acting from outside, such as distortions in the steering column, elastic influences or different thermal expansions of the individual components in relation to one another, which adversely influence the functioning of previous rotary slide valves, are avoided. Production tolerances can also be compensated in terms of their influences on the functioning of the rotary slide valves.

Assembly is carried out merely by joining together axially; this affords advantages with regard to the outlay in terms of production and assembly.

Assembly may also be carried out fully automatically with the aid of force/path monitoring, thus leading to a higher reproducibility of quality and functioning.

Advantageous and expedient refinements of the invention are specified in the subclaims. However, the invention is not restricted to the feature combinations of the claims, but, instead, the set object affords a person skilled in the art with further expedient combination possibilities of claims and individual claim features.

An exemplary embodiment of the present invention is described below, in principle, with reference to the figures of which:

Figure 1 shows a longitudinal section through a rotary slide valve according to the invention by the example of a rack-and-pinion power-assisted steering system of motor vehicles;

Figure 2 shows a detail of a rotary slide valve according to the invention on an enlarged scale, and

Figure 3 shows a section along the line III-III of the detail of a rotary slide valve according to the invention which is illustrated in figure 2.

The invention is described with reference to the example of a rotary slide valve for a rack-and-pinion power-assisted steering systems. The invention may, however, also be applied, to the same effect, to other power-assisted steering systems, for example ball-and-nut power-assisted steering systems.

A rotary slide valve 1 according to the invention contains a first valve element in the form of a rotary slide 2 and a second valve element which is designed as a control bush 3.

The rotary slide 2 is connected fixedly in terms of rotation to a valve input member 4 which may be designed as a steering spindle connection. The steering spindle connection is connected, for example, to a steering spindle, not illustrated, which carries a steering handwheel, via a cardan joint which is likewise not illustrated. Moreover, the rotary slide 2 is connected to a valve output member 5 via a backlash coupling, not illustrated.

The valve output member 5 may be designed as a driving pinion or as a ball screw, depending on use in rack-and-pinion or ball-and-nut power-assisted steering systems.

Arranged on the outer cylindrical surface of the rotary slide 2 are longitudinal control grooves 6 which cooperate with longitudinal control grooves 7 of the control bush 3.

Depending on the direction of rotation, the rotary slide valve 1 makes a pressure-medium connection with a servomotor, not illustrated, via the longitudinal control grooves 6 and 7 and via annular grooves 8 in the control bush 3.

Furthermore, the valve input member 4 is connected to the valve output member 5 via a torsion-bar spring 9. The valve output member 5, in turn, is connected fixedly in terms of rotation to the control bush 3 via a connecting element 10. These various connections with one another make it possible to have a limited relative rotation of the rotary slide 2 in relation to the control bush 3. As a result of this relative rotation of the valve elements in relation to one another, the pressure medium conveyed by a power-steering pump, not illustrated, is conducted, via a pressure-medium reservoir, likewise not illustrated, from the relieved working space of

the servomotor, not illustrated, into the loaded working space of the latter.

The coupling of the valve output member 5 and the control bush 3 is carried out by means of a connecting element 10 which is connected in one piece to the control bush 3 here. The connecting element 10 is pressed into the valve output member 5 and is secured against rotation by means of a boss contour 11. This allows a play-free take-up. The connecting element 10 is connected to the valve output member 5 in a connection region 12. The connection region 12 is spatially separated from a control region 13 of the control bush 3 by means of a region 14. In this region 14, at least one cut 15 is made, which ensures torsional rigidity and flexibility of this region 14.

Reference symbols

1. Rotary slide valve
2. Rotary slide
3. Control bush
4. Valve input member
5. Valve output member
6. Longitudinal control grooves (rotary slide)
7. Longitudinal control grooves (control bush)
8. Annular grooves
9. Torsion-bar spring
10. Connecting element
11. Boss contour
12. Connection region
13. Control region
14. Region
15. Cut

Patent Claims

1. Rotary slide valve (1) for power-assisted steering systems of motor vehicles, with a first valve element which is connected fixedly in terms of rotation to a valve input member (4), and with a second valve element which is connected fixedly in terms of rotation to a valve output member (5), the first valve element being connected to the valve output member (5) via a torsion-bar spring (9) and by a backlash coupling, the two valve elements being arranged in a valve housing so as to be movable coaxially one in the other and being rotatable relative to one another at most by the amount of the rotary travel of the backlash coupling, and the radially outer valve element having inner and the radially inner valve element outer longitudinal control grooves (6, 7) which are limited at least partially in their axial length and which may also be designed conically for purposes of adjustment of characteristic curves, said grooves cooperating with one another in order to control a pressure medium to and from two working spaces of a servomotor, characterized in that the first valve element is connected to the valve output member (5) via a connecting element (10) and has at least one cut (15) in a region (14) between a connection region (12) and a control region (13)

2. The rotary slide valve (1) as claimed in claim 1, characterized in that the connection of the two parts is made positively and nonpositively, for example the connecting element (10) or the valve output member (5) has a boss contour (11).

3. The rotary slide valve (1) as claimed in claim 1, characterized in that the region (14) is torsionally rigid and flexible.

4. The rotary slide valve (1) as claimed in claim 1, characterized in that the cut (15) is continuous.

5. The rotary slide valve (1) as claimed in claim 1, characterized in that the cut (15) is designed in the form of a groove.

6. The rotary slide valve (1) as claimed in claim 1, characterized in that the region (14) is designed as a hollow shaft.

7. The rotary slide valve (1) as claimed in claim 1, characterized in that the region (14) is designed as a solid shaft.

8. The rotary slide valve (1) as claimed in claim 1, characterized in that the region (12) is designed as a polygonal profile.

9. The rotary slide valve (1) as claimed in claim 1, characterized in that the cuts (15) are made by means of high-energy beam cutting, plasma cutting, erosion cutting, punching, grinding or milling.

10. The rotary slide valve (1) as claimed in claim 1, characterized in that the connecting element (10) is produced at least in one piece with the control bush (3).

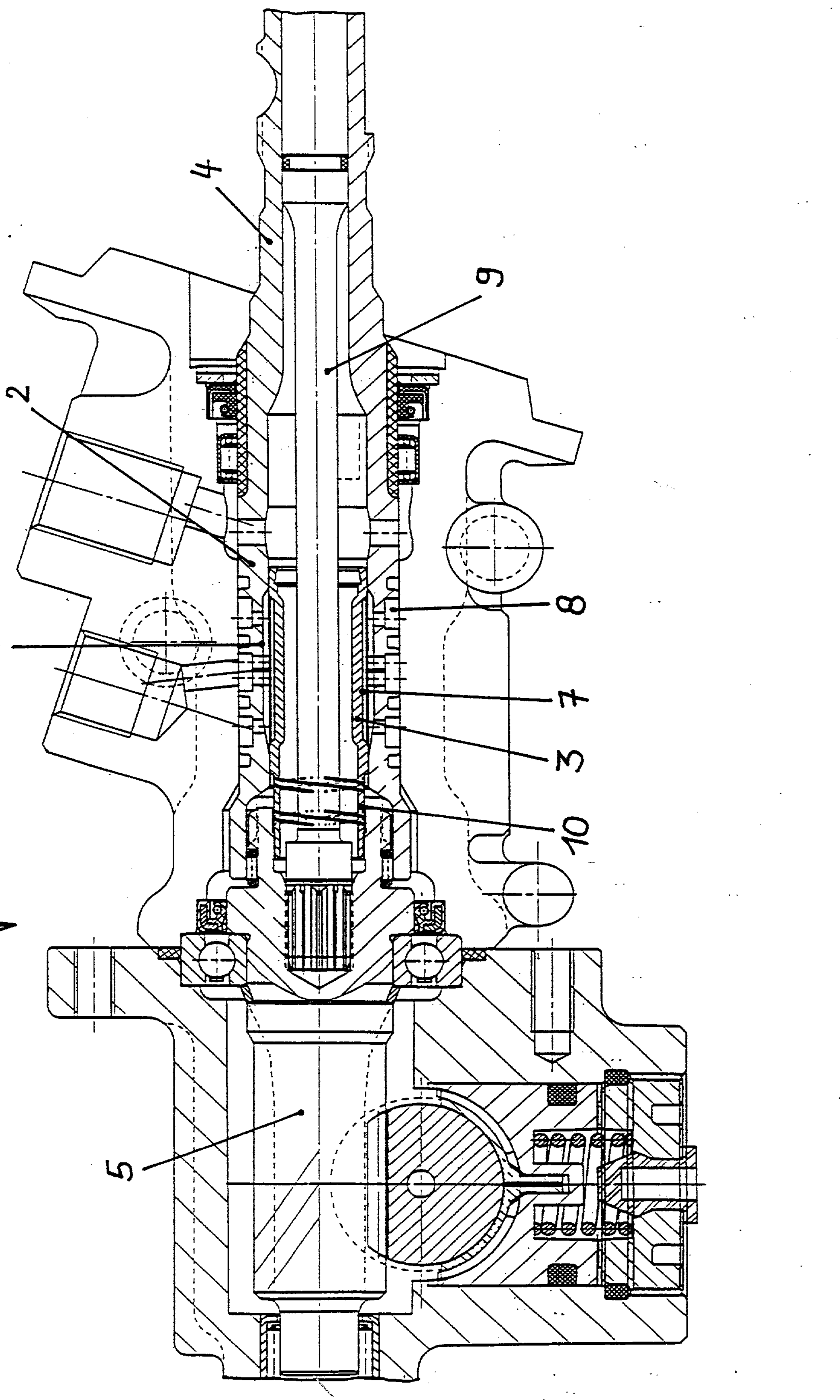
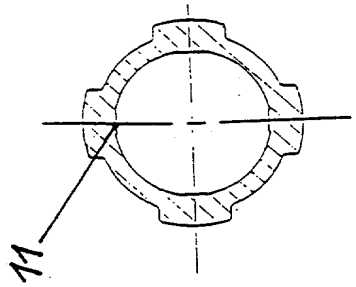


Fig. 1

Fig. 3



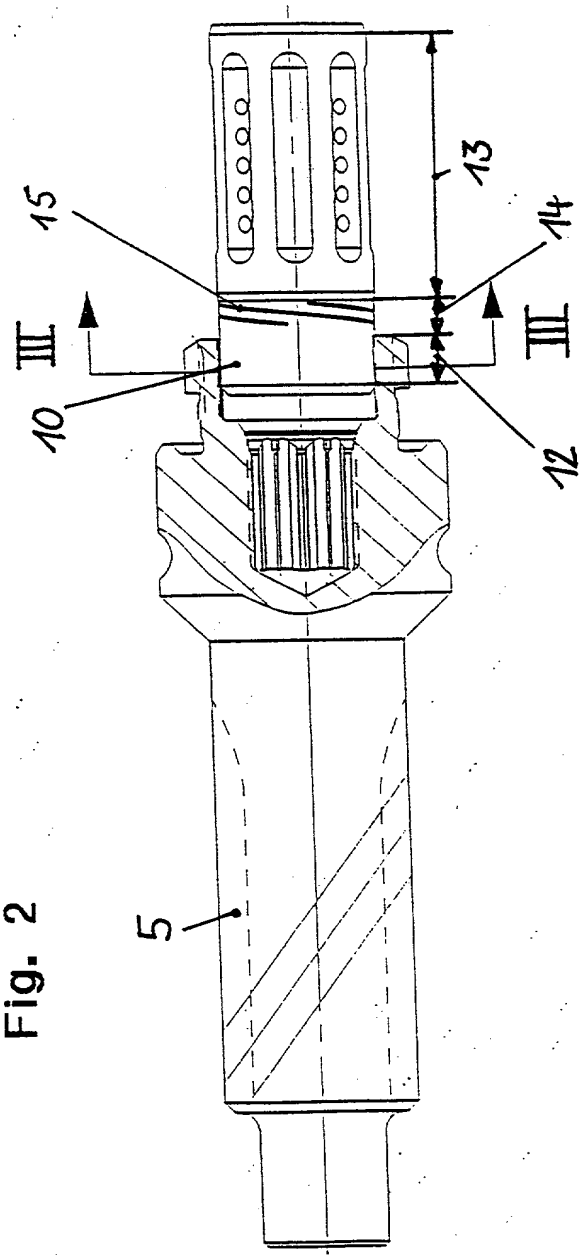


Fig. 2

[11839/12]

DECLARATION AND POWER OF ATTORNEY

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter that is claimed and for which a patent is sought on the invention entitled **ROTARY SLIDE VALVE FOR POWER-ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES**, the specification of which was filed as International Application No. PCT/EP00/04072, on 6 May 2000, an English translation of which is enclosed herewith.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose information that is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate filed by me on the same subject matter having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

(Number)	(Country)	(Day/month/year filed)	Priority Claimed Under 35 USC 119	
199 21 745.9	Fed. Rep. of Germany	11 May 1999	Yes X	No _

And I hereby appoint Richard L. Mayer (Registration No. 22,490) my attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please address all communications regarding this application to:

KENYON & KENYON

26646

PATENT TRADEMARK OFFICE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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